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Interim Report

ORSER-SSEL Technical Report 14-73

LAND USE MAPPING

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INTERDISCIPLINARY APPLICATION AND INTERPRETATION OF ERTS DATA WITHIN THE SUSQUEHANNA RIVER BASIN

Resource Inventory, Land Use, and Pollution

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Original photography may be purchased from:
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10th and Dakota Avenue
Sioux Falls, SD 57198

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This project was designed as a test of the hybrid approach to data processing, developed by ORSER (described in ORSER-SSEL Technical Report 13-73). An area just south and west of Harrisburg, Pennsylvania, was chosen because the same area had been used in the development of the hybrid approach and it was thought desirable to be able to compare the results of the two studies. Three constructive frames of U2 photography (nos. 13, 14, and 15) from sensor 14 of flight 72-124, flown in July 1972, were used. These were mounted between glass plates and projected onto the digital output, using an American Optical Company Delineascope, Model D. One of these photographs is shown in Figure 1. Digital data from ERTS-1 scene 1080-15185, collected October 11, 1972, were used in the analysis. A portion of the channel 7 image of this scene is shown in Figure 2.

Procedure

After the study area was subset from the NASA tapes onto working tapes, NMAP[1] and UMAP were run for review of definable boundaries and selection of the first set of training areas. The most easily recognized targets from spectrally homogeneous areas with positive widely separated geographic locations were chosen. (The Susquehanna River is an excellent example of such a target.) These targets were positively identified by projecting the U2 photograph onto the NMAP output. Scale distortions of this map, however, prevented proper registration of the photo over the entire area of the map. This required a distribution of positively identified targets throughout the area in order that adjacent portions of the scene could be sequentially brought into proper registration. Areas 10 to 25 cm square (representing approximately 0.2 to 0.4 square miles) could be brought into registration by this method.

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[1]For complete program descriptions, see ORSER-SSEL Technical Report 10-73.

PRINT NOT YET AVAILABLE

Figure 1: Black and white enlargement of a portion of the U2 photograph of the Harrisburg area. (Flight 72-124, sensor 14, frame 15; approximate scale:

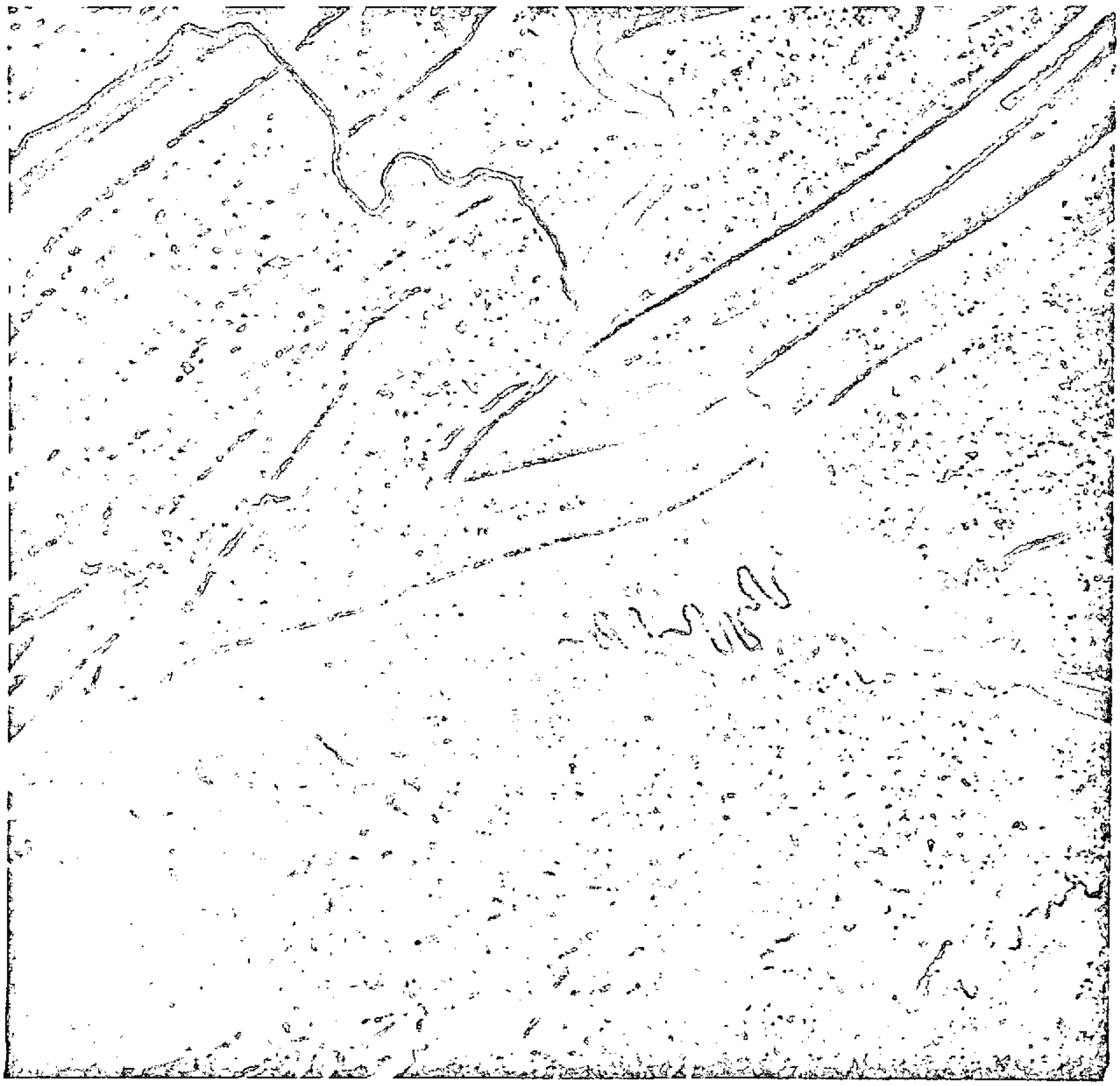

Figure 2: Enlargement of a portion of the channel 7 ERTS-1 image of the Harrisburg area. (Image 1080-15185, October 11, 1972; 1 inch equals approximately 5.7 miles)

As thematic maps were produced, using the STATS and DCLASS programs, they were refined and new training areas were chosen by comparison with the U2 photograph. These maps were produced in separate categories (such as all vegetation) for ease of checking. Figure 3 [1] shows such a map. Note first the easily recognized Susquehanna River on the upper right, with the meandering Conodoguinet Creek entering from the left. In addition to the river and the creek, the map shows the categories of OPEN LAND, FOREST, and GOLF COURSE. Some areas verified by correlation with the U2 photograph are outlined on this map. Lesser areas, now geographically fixed and interpreted from the photograph, were then defined. The number and variety of targets was thus expanded with respect to both the type and the extent of geographic separation. This cyclic operation was repeated until it was considered necessary to use cluster analysis where uniform areas of sufficient size could not be found to define training areas for the STATS program. The DCLUS program, which uses the techniques of cluster analysis to find signatures for areas of small size or spectral nonhomogeneity, was then applied. The majority of training areas processed with this program were selected by the photointerpreters on the U2 photograph and then correlated with the computer map. (The industrial and suburban categories shown in Figure 4 were developed in this way.) The map was verified by correlation with the U2 photography and the targets successfully defined were outlined. This comparison revealed that one of the areas mapped as suburban also included a considerable number of agricultural fields (the category of SUBURB CONFUSION in Figure 4). When one considers the mixed character of a suburban area, consisting of roofs, lawns, shrubs, and streets, it is easy to see how some of those combinations might resemble a mixture of small fields or long and narrow fields resulting from contour plowing. The signature for this category (number 2) and that for FIELD (number 3), shown in Table 1 , reveal that these two signatures do not have a wide separation. Thus, confusion between these two categories could be anticipated. In contrast, the separability of category 1 (RIVER) from every other category is quite large, implying

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[1] Figures 3, 4, and 5 were transcribed from the character maps using the program LMAP, which corrects for the distortion of scale inherent in the character map output on the printer.

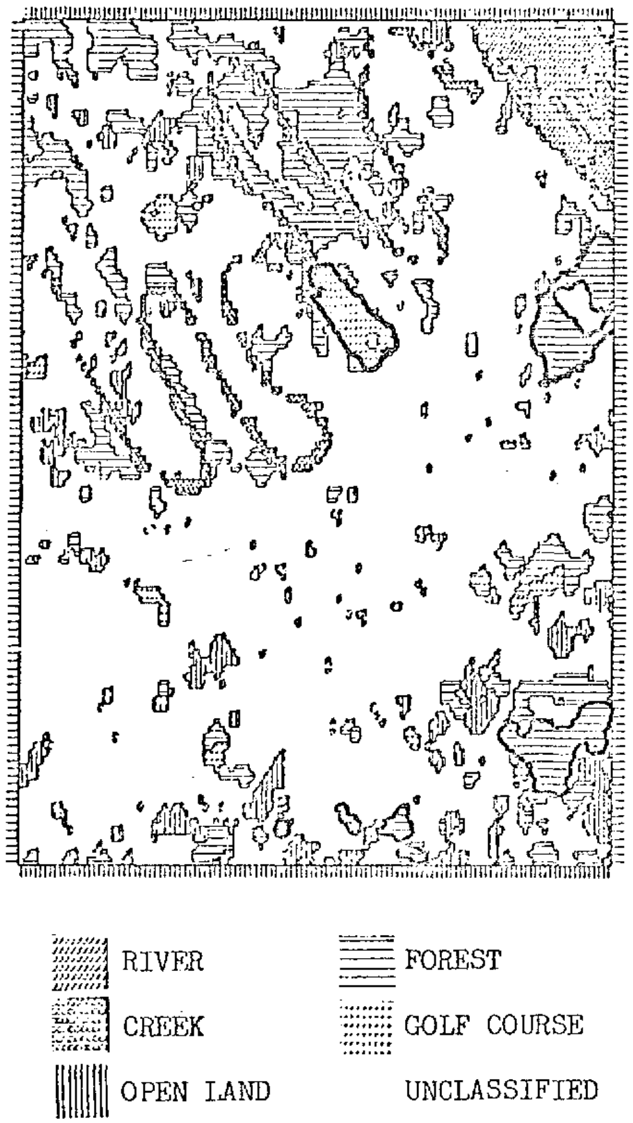

Figure 3 : Classification map of vegetation categories. (Plotted on the CALCOMP plotter, using the LMAP program.)

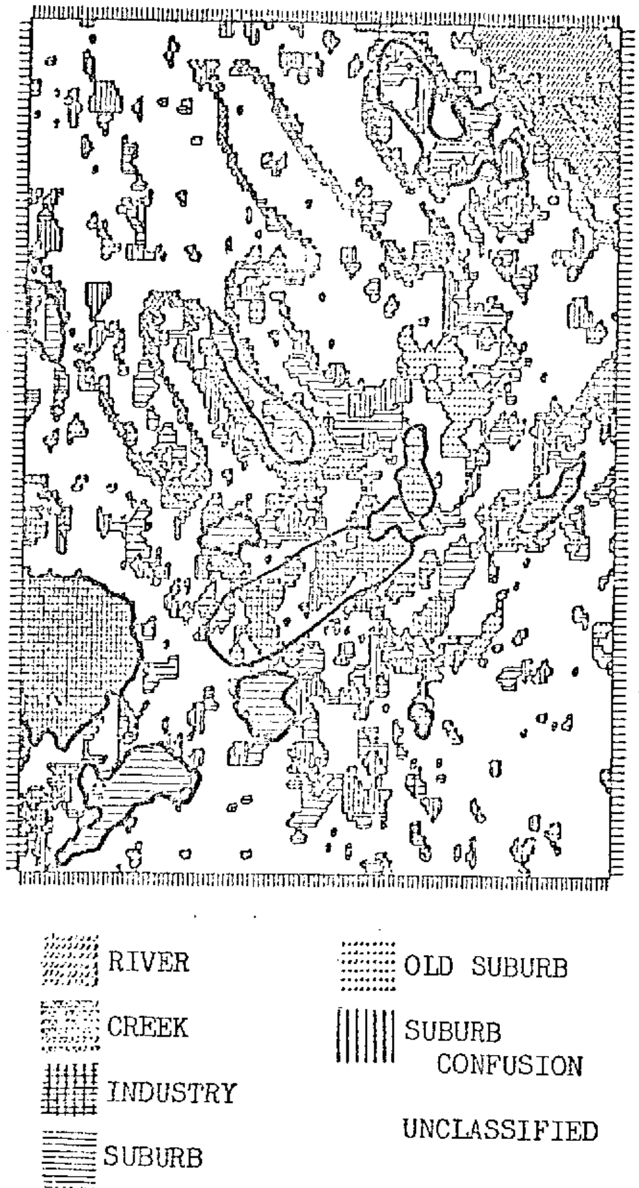

Figure 4: Classification map of industrial and suburban categories. (Plotted on the CALCOMP plotter, using the LMAP program.)

Table 1: Distances of Separation for Some Categories Used in Mapping the Harrisburg Area

Name	Number	1	2	3	4	5
RIVER	1	0.0	31.8	31.5	14.2	31.4
SUBURB CONFUSION	2	31.8	0.0	1.1	18.3	14.2
FIELD	3	31.5	1.1	0.0	18.0	13.8
INDUSTRY 1	4	14.2	18.3	18.0	0.0	17.7
INDUSTRY 2	5	31.4	14.2	13.8	17.7	0.0

no problem in classifying this category correctly. A mixture of two categories (4 and 5) was found to consistently appear in industrial areas on the initial output. Although these two signatures were relatively widely separated, and thus retained as separate entitites, they were assigned to the same symbol (+), thus yielding a uniformly mapped area on the output. More work is required with the category of HIGHWAYS. It comes up well in areas of high subject-to-background contrast, but is weak in urban and suburban areas. Perhaps the mapper will have to produce highway networks by the judicious connection of scattered symbols. This is not a satisfactory procedure. Other spectrally nonhomogeneous targets definable by cluster analysis that are different but worthy of further study are quarries and small streams.

In the third and final level of mapping, the thematic map was reviewed for clarity. At this stage the resulting map output was too refined and confusing to the reader. Some categories were combined, as explained above for the industrial areas. Stray symbols were suppressed using the CLEAN option. A careful review of map objectives at this stage served as a guide to the final number of categories to be mapped. The final output also includes a table expressing the percentage of the area mapped for each category. Figure 5 is the completed map. It represents a combination of the maps shown in Figures 3 and 4. However, in order to make the map readable, forest areas were combined with unclassified areas. The hope of diminishing the unclassified area may rest in the merging of data from scenes for different seasons of the year.

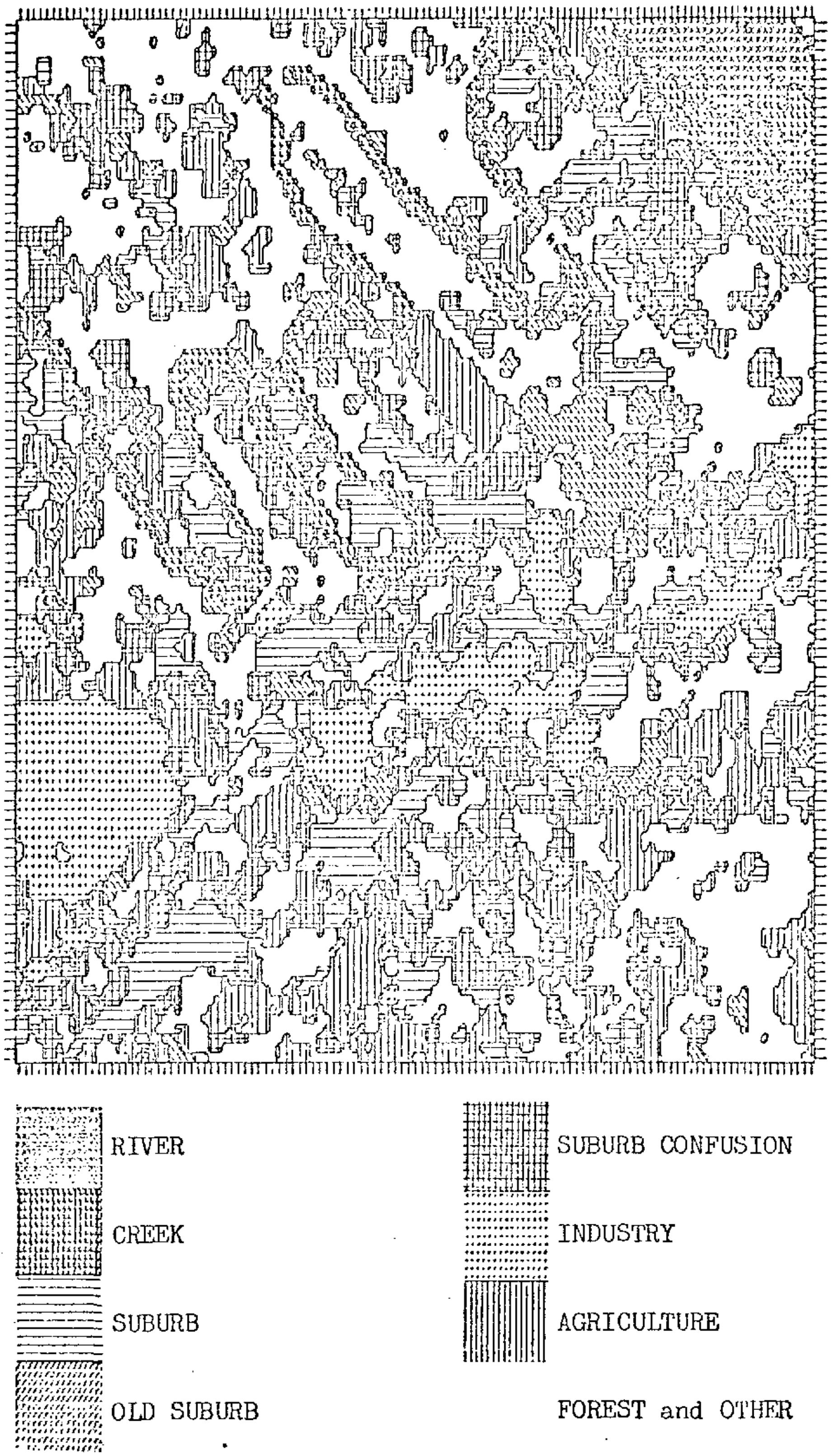

Figure 5: Classification map of all categories. (Plotted on the CALCOMP plotter, using the LMAP program.)

Results and Conclusions

The following results and conclusions were drawn from this study:

1. The categories of water, forests, high density suburbs, old suburbs, industrial areas, and parking lots and concrete were reasonably well defined.

2. The categories of agricultural fields, highways, and low density suburbs need more study.

3. Some items highly desirable in land use mapping may not be obtained because of small size or low subject-to-background contrast.

4. The temporal aspect of the data has not yet been sufficiently exploited.

5. The combined efforts of interpretation of ERTS images, aircraft underflight photographs, and computer-generated character maps has the potential to generate land-use maps of high quality.

It should be added that subsequent efforts to further refine the techniques described here were hampered by the inability to pinpoint small geographic areas on the thematic maps because of the line-and-element distortion inherent in the character maps generated by the printer. ORSER has just received a Zoom Transferscope from Bausch and Lomb. The use of this device with color transparencies of underflight photography should offer great improvement over the method of simple projection, because of the differential scale adjustments possible with this instrument.

Aircraft underflight data are vitally important to the ultimate refinement of thematic maps from ERTS digital data. In order to make maximum use of the photointerpreter in the establishment of signatures, it is necessary to provide images at a larger scale than that of ERTS-1 MSS prints, in order that microfeatures may be read. As these features are properly identified with underflight data, they can be used to establish computer processed signatures for subsequent mapping of large areas.
